

*can't find m. l. l. 2ms*

DS-2709  
MODEL SPECIFICATION  
SATURN S-IVB-F STAGE

1 DECEMBER 1965

MISSILE & SPACE SYSTEMS DIVISION  
DOUGLAS AIRCRAFT COMPANY, INC.  
SANTA MONICA/CALIFORNIA

FACILITY FORM 602

N70-75940	
(ACCESSION NUMBER)	(THRU)
50	none
(PAGES)	(CODE)
CR-113334	
(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)



DS-2709  
MODEL SPECIFICATION  
SATURN S-IVB-F STAGE

1 DECEMBER 1965

PREPARED FOR:  
NATIONAL AERONAUTICS AND  
SPACE ADMINISTRATION  
UNDER NASA CONTRACT NAS7-101

***DOUGLAS MISSILE & SPACE SYSTEMS DIVISION***  
SPACE SYSTEMS CENTER — HUNTINGTON BEACH, CALIFORNIA

**SPECIFICATION CHANGE LOG**SPECIFICATION NO. DS-2709AS OF March 31, 1965

SUPERSEDING \_\_\_\_\_

SCN NO.	ECP NO.	CONTRACT AUTHORITY	SCN DATE	PAGES AFFECTED	ITEM AFFECTED



## END ITEM CONFIGURATION CHART

SPECIFICATION NO. DS-2709

PAGE \_\_\_\_\_

SPECIFICATION ISSUE	ECP'S	CONTRACT AUTHORITY	PRODUCTION EFFECTIVITY
<p>NEW</p> <p>1 Dec. 1965</p>	<p>This issue of Model Specifi- cation DS-2709 reflects design/ performance requirements for Saturn S-IVB-F Stage configur- ation required by Contract NAS7-101 inclusive of contract- ual documents issued through 31 March 1965.</p>		<p>S-IVB-F</p>

### ABSTRACT

DAC (Douglas Aircraft Company) Model Specification DS-2709, Model Specification, Saturn S-IVB-F Stage, describes in general the design requirements for both the Saturn IB and Saturn V configurations of the S-IVB-F Stage and its associated subsystems. S-IVB-F is the designation given to the S-IVB Facility Check-out Stage.

The design requirement characteristics of the stage are divided according to function into the following main sections: propulsion, electrical/electronic, and mechanical systems. Information pertinent to ordnance devices, weight, and launch safety provisions are also provided; quality assurance provisions, applicable documents, general requirements, etc., are also included.

## PREFACE

This specification, DS 2709, is prepared for NASA/MSFC (National Aeronautics and Space Administration/Marshall Space Flight Center) under Supplemental Agreement 850 of Contract NAS7-101.

Appendix A to this specification lists applicable contract modifications, i.e., CCN's (Contract Change Notices), supplemental agreements, change orders, and contract letters, initiated through 31 March 1965. Language changes associated with these modifications have been incorporated.

SECTION I  
SATURN S-IVB/S-IB-1

TABLE OF CONTENTS

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
	ABSTRACT	ii
	PREFACE	iii
1.	INTRODUCTION	1
1.1	Scope	1
1.2	Vehicle Description	1
1.3	Mission Description	1
2.	APPLICABLE DOCUMENTS	2
2.1	General	2
3.	CONFIGURATION DESCRIPTION	3
3.1	General	3
3.2	Structure	3
3.2.1	Forward Skirt	4
3.2.2	Propellant Tank Assembly	5
3.2.3	Thrust Structure	5
3.2.4	Aft Skirt	6
3.2.5	Aft Interstage	6
3.2.5.1	Saturn IB Configuration	6
3.2.5.2	Separation Plane	7
3.2.6	Tunnels	7
3.2.7	Targets	7
3.2.8	Stage Alignment	7
4.	PROPULSION SYSTEM	8
4.1	General	8
4.2	Engine	8
4.3	Propellants and pressurants	8
4.4	Propellant Tanks	8
4.5	Liquid Hydrogen Pressurization	9
4.6	Liquid Oxygen Pressurization	9

SECTION I  
SATURN S-IVB/S-IB-1

TABLE OF CONTENTS (cont'd)

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
4.7	Pneumatic Control System	10
4.8	Propellant Fill, Drain, and Umbilical Connections	10
4.9	Propellant Feed Lines	10
4.10	Propellant Vent Lines	10
4.11	Propellant Recirculation Chillover System	11
4.12	Auxiliary Propulsion System	11
4.13	Leak Detection System	11
4.14	Firings and Calibrations	11
4.15	Purging Requirements	11
5.	ELECTRICAL/ELECTRONIC SYSTEMS	12
5.1	General	12
5.2	Power Requirements	12
5.3	Interface Wiring	12
5.4	Propellant Utilization System	12
5.5	Instrumentation	13
5.6	Electrical Umbilical Disconnects	13
6.	MECHANICAL SYSTEMS	14
6.1	General	14
6.2	Hydraulic Power System	14
6.3	Umbilicals	14
6.4	Environmental Control System	14
6.4.1	General	14
6.4.2	Aft Skirt and Aft Interstage	15
6.4.3	Forward Skirt	15
7.	ORDNANCE EQUIPMENT	16
7.1	General	16
7.2	Saturn IB Ordnance Equipment	16



SECTION I  
SATURN S-IVB/S-IB-1

TABLE OF CONTENTS (cont'd)

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
8.	WEIGHT	17
8.1	General	17
9.	LAUNCH SAFETY PROVISIONS	18
9.1	General	18
10.	GENERAL REQUIREMENTS	19
10.1	Data Acquisition and Processing System	19
10.2	Human Factors Engineering	19
10.3	Materials and Processes	19
10.4	Preparation-for-Delivery Requirements	19
10.5	Quality Assurance Provisions	19
10.6	Government-furnished Equipment Requirements	19
10.7	Documentation	19
10.8	Exterior Finish	19
	Appendix A	20
		21
	Appendix B	22
		23
	Appendix C	24
	Appendix D	25
	Appendix E	26
		27
	SECTION II - SATURN S-IVB/S-IB-1	
	TABLE OF CONTENTS	27 (a)

1. INTRODUCTION

1.1 Scope - This specification defines the characteristics necessary to satisfy the S-IVB-F requirements for both the Saturn IB and Saturn V Facility Checkout Vehicles. Typical performance requirements, structural design criteria, and design and performance descriptions of the various associated subsystems are presented. DAC is developing the S-IVB-F stage for NASA/MSFC.

The Saturn IB/S-IVB-F stage is the second stage of the Saturn IB Facility Checkout Vehicle. The Saturn V/S IVB-F is the third stage of the Saturn V Facility Checkout Vehicle.

1.2 Vehicle Description - The Saturn IB Facility Checkout Vehicle consists of the S-ID-F and S-IVB-F stages and the S-IU-200F. The Saturn V Facility Checkout Vehicle consists of the S-IC-F, S-II-F, and S-IVB-F stages and the S-IU-500F.

1.3 Mission Description - The primary mission of the S-IVB-F stage will be to provide initial Saturn IB Beta III Test Stand checkout at Sacramento and the initial Saturn IB and Saturn V launch complex checkout at Kennedy Space Center by accomplishing propellant loading, partial pneumatic servicing, and compartment purge system tests.

2. APPLICABLE DOCUMENTS

2.1 General - The specifications, standards, publications, etc., applicable to the design and development of the S-IVB-D Stage will be in general accordance with the Specification and Deviation Document, SM-41411, dated 12 December 1964.

3. CONFIGURATION DESCRIPTION, S-IVB/S-IB-1 (Saturn V in Section II)

3.1 General - The S-IVB-F stage will be designed to provide GSE (ground support equipment) and S-IB and Instrument Unit mechanical and electrical interfaces physically identical to Saturn IB/S-IVB Flight Stage 201. Functional requirements of the stage are limited to those required to safely accomplish and monitor propellant loading and unloading, partial pneumatic servicing, and compartment purges in accordance with DAC-proposed countdown procedures. The functional portions of the interfaces will be identical to those of Flight Stage 201 except for the S-IVB-F-peculiar temperature and pressure instrumentation functions that are to be routed through the S-IVB-F DDAS in addition to the applicable flight configuration functions normally routed through the S-IVB DDAS. The S-IVB-F-peculiar temperature and pressure instrumentation will be limited to fifteen temperature and fifteen pressure transducers and the stage signal-conditioning equipment required therefor.

The S-IVB-F stage basic design criteria will conform to the criteria delineated in DS-2163, except as modified to satisfy the requirements of the S-IVB-F mission.

3.2 Structure - The S-IVB-F stage will be a single-stage structure which, when fully loaded and with the propellant tanks pressurized to the maximum values, will withstand all loads imposed during normal facility checkout operations. The stage will also have free-standing capability on the launch pad (1) when staged as a complete Saturn IB vehicle, (2) with the S-IVB-F and all upper stages empty or fully loaded, and (3) with the S-IVB-F pressurized or unpressurized. The stage will also be designed to withstand ground handling without pressurization when empty. Propellant loading will be accomplished with the stage in the erect position only. The stage will substantially conform to flight configuration, except for those parameters not required for mission performance. Protruding flight equipment which is not required will be simulated by envelope mockup units which will be furnished in kits for installation at KSC. The basic S-IVB-F airframe will consist of the following major structural assemblies:

- a. Forward skirt
- b. Propellant tank assembly
- c. Thrust structure
- d. Aft skirt
- e. Aft interstage

Descriptions of these assemblies are given in the following paragraphs; all dimensions given are approximate.

3.2.1 Forward Skirt - The forward skirt will be fabricated from 7075-T6 aluminum. The skirt will be of skin/stringer construction, with external stringers extending beyond the nominal 260-inch diameter. Cylindrical in shape, the skirt will extend 122 inches forward from the intersection of the LH<sub>2</sub> tank sidewall and the forward dome. Provisions will be made to allow installation of the LH<sub>2</sub> vent umbilical, telemetry antenna fairings, and the DAC forward electrical umbilical. Forward skirt functional thermal conditioning plates and related plumbing will not be provided.

The forward skirt will terminate at a field splice connecting to the MSFC-supplied Instrument Unit. Access to the skirt area will be provided by an access door in the Instrument Unit. A platform in the S-IVB forward skirt will provide access to both MSFC and DAC electronic equipment in the skirt/Instrument Unit area. DAC will not make provisions for any umbilical requirements associated solely with the Instrument Unit.

3.2.2 Propellant Tank Assembly - The propellant tank assembly will consist of a tank cylinder 268 inches in length and 260 inches in diameter, with two hemispherical end bulkheads and an intermediate spherical radius bulkhead. The concave side of the intermediate or common bulkhead will face aft, and will be attached by a compression ring to the aft bulkhead. The  $\text{LH}_2$  tank will be forward and the  $\text{LO}_2$  tank aft. The propellant tanks will be fabricated from 2014-T6 aluminum. The cylindrical portion of the  $\text{LH}_2$  tank will be lightened by milling a waffle pattern on the interior surface. The entire inner surface of the  $\text{LH}_2$  tank (with the exception of its side of the common bulkhead) will be insulated with the improved 3-D polyurethane foam. The common bulkhead will be formed by bonding aluminum skins over a fiberglass honeycomb core. There will be no penetrations of any kind in the surfaces of the common bulkhead. The common bulkhead will be designed to withstand the differential pressure resulting from a limit pressure of 42 psia in the  $\text{LH}_2$  tank, opposing 14.7 psia in the  $\text{LO}_2$  tank when the stage is on the ground. The common bulkhead will have insulation properties sufficient to maintain the  $\text{LO}_2$  at the proper temperature during a 12-hour ground hold. The end bulkheads will be made from "pie" segments chemically etched for weight reduction and welded externally to form a hemisphere. The forward bulkhead will contain a manhole 28 inches in diameter for access to the  $\text{LH}_2$  tank. The  $\text{LO}_2$  sump in the aft bulkhead will serve as an access manhole in the  $\text{LO}_2$  tank. The tankage will be sized for 230,000 pounds of usable propellants, plus a subsidiary propellant allowance. The S-IVB-F propellant tank assembly will be of production configuration.

3.2.3 Thrust Structure - The thrust structure will consist of an inverted truncated cone with a base diameter of 168 inches, a top diameter of 34 inches, and a height of 62 inches. The structure will be fabricated from 7075-T6 aluminum, will be of skin/stringer construction, and will be attached to the engine support fitting, forming an integral unit. The thrust structure will be attached to the  $\text{LO}_2$  tank aft bulkhead by means of a bolted joint. Access to the inside of the thrust structure will be provided by two doors having a trapezoidal opening of 34 by 24 by 22 inches.

The thrust structure will be of basic Saturn V production configuration, but will not have engine-gimballing capability. Engine actuators will not be installed, nor will the J-2 engine be furnished. The engine-mounted heat exchanger will also not be provided. Provisions for incorporating the Saturn V ambient helium bottles will be included in the Saturn IB configuration.

3.2.4 Aft Skirt - The aft skirt will be a cylinder with a nominal diameter of 260 inches and a length of 85 1/2 inches. The skirt will be fabricated of 7075-T6 aluminum skin, with external stringers extending beyond the nominal 260-inch diameter. The forward end of the skirt will be attached to the propellant tanks near the girth weld of the aft dome and tank cylinder, the aft end mating with the aft interstage.

The aft skirt will be of Saturn IB production configuration (before modification by Change Order 146), with Saturn IB aft interface mounting holes and electrical connectors for attachment to the Saturn IB aft interstage. The skirt will initially have a IB electrical-connector interface. The skirt will include a flight-type aft umbilical panel. In addition, the skirt will have provisions for installing one Saturn IB configuration Auxiliary Propulsion System (APS) module to be functional only in regard to propellant tanking/detanking operations and safety equipment associated therewith. APS engines will not be provided. In addition, one APS mockup and three ullage rocket fairings, and the CDF Train (inert) will be provided.

### 3.2.5 Aft Interstage

3.2.5.1 Saturn IB Configuration - The Saturn IB/S-IVB-F aft interstage will be cylindrical in shape and will extend 224 1/2 inches aft from the aft skirt/aft interstage field splice. The interstage will be constructed of 7075-T6 aluminum, with external stringers extending beyond the 260-inch nominal diameter. There will be eight equally-spaced hard points with attachments on an approximate 220-inch diameter at the S-IB-F/S-IVB-F interface.

The S-IB aft interstage will be of production configuration and will contain provisions for mounting the 1A50670 dummy retro-rocket in any one of the four locations. Four retro-rocket fairing and mounting provisions will be supplied.

3.2.5.2 Separation Plane - The S-II-F/S-IVB-F separation plane will be located near the aft skirt/aft interstage field splice.

3.2.6 Tunnels - The external tunnel connecting the engine compartment to the forward skirt area shall be designed to accommodate cables, tubing, and other S-IVB-F stage requirements. The auxiliary tunnel connecting the cold helium bottle outlets with the forward skirt area will be designed to accommodate tubing, wiring, and other S-IVB stage requirements.

3.2.7 Targets - Stage alignment verification targets will be provided for the Saturn IB and Saturn V configurations.

3.2.8 Stage Alignment - Stage alignment brackets for the forward skirt to the Instrument Unit will be provided for the Saturn IB and Saturn V configurations.

Brackets for the aft skirt to interstage alignment will not be provided for the Saturn IB or Saturn V configurations.



#### 4. PROPULSION SYSTEM

4.1 General - The S-IVB-F propulsion system will consist of the necessary equipment to safely accomplish propellant loading and unloading, tank pressurization, and propellant monitoring functions. The propulsion system installed will be of production configuration, except as modified for performance of the S-IVB-F mission.

4.2 Engine - The main propulsion system J-2 engine will not be installed. Engine gimbaling capability will not be provided, and the engine-mounted heat exchanger will not be furnished. A dummy inert mass will be installed to simulate the J-2 engine mass. The dummy engine will be furnished as a kit for installation at KSC. The engine actuators will not be installed or simulated. The engine feed lines will not be provided. The J-2 engine chilldown system will not be provided.

4.3 Propellants and Pressurants - Propellants and pressurants required for S-IVB-F stage development and testing will be GFE and will conform to the following requirements:

- a.  $\text{LO}_2$  shall conform to Specification MIL-P-25508 and Federal Specification BB-O-925;
- b.  $\text{LH}_2$  shall conform to Specification MIL-P-27201, and shall have a minimum of 95 per cent parahydrogen when manufactured with an impurity maximum of two parts per million; (the remainder shall be orthohydrogen.)
- c. Nitrogen shall conform to Specification MIL-P-27401;
- d. Helium shall be Grade A, 99.993 per cent pure, and produced by the Bureau of Mines.

4.4 Propellant Tanks - The  $\text{LH}_2$  and  $\text{LO}_2$  tanks will form an integral part of the stage structure. Mainstage propellant capacity of these tanks will be approximately 230,000 pounds, plus a subsidiary allowance. The volume of the  $\text{LH}_2$  tank will be approximately 10,377 cubic feet, including approximately 4 per cent ullage volume. The volume of the  $\text{LO}_2$  tank will be approximately 2,828 cubic feet, including approximately 2.6 per cent ullage volume. No anti-vortex screen will be provided at either tank outlet.

4.5 Liquid Hydrogen Pressurization - The  $\text{LH}_2$  tank pressurization system will be of production configuration, but will be limited to the necessary hardware to accomplish prepressurization of the  $\text{LH}_2$  tank plus the fuel tank on-board pressure supply (for both Saturn IB and Saturn V) from a GFE (Government-furnished equipment) ground source. The Saturn V design only will provide an on-board ambient repressurization system, including seven helium bottles mounted around the thrust structure and pressurized from a GFE ground source. The bottles will be installed during conversion to Saturn V.

4.6 Liquid Oxygen Pressurization - The  $\text{LO}_2$  tank pressurization system will be of production configuration, but will be limited to the necessary hardware required to prepressurize the  $\text{LO}_2$  tank, plus the oxidizer tank on-board pressure supply from a GFE ground source of cold helium. Both the Saturn IB and Saturn V configurations of the  $\text{LO}_2$  tank will be prepressurized to approximately 33.5 plus or minus 1.5 psia (pounds per square inch absolute) from the ground source.

Helium pressurization spheres will be located in the  $\text{LH}_2$  tank to maintain pressurizing gas for the  $\text{LO}_2$  tank. The spheres will be secured on the tank wall at the tunnel so that all plumbing and connections are outside the tank. The spheres will be nominally pressurized to 3,000 psia from the ground source of cold helium. The line connecting the cold helium spheres to the  $\text{LO}_2$  tank will be capped.

The  $\text{LO}_2$  tank will be protected from overpressurization by dual relief provisions. The cold helium system will contain a pressure-relief valve to protect the spheres from temperature changes. A remote-controlled bleed valve will be provided to permit emergency removal of the high-pressure gas.

The Saturn V configuration will have an  $\text{LO}_2$  tank repressurization system that will include two ambient high-pressure helium bottles mounted around the thrust structure and filled from a GFE ground source. The helium bottles will be installed during conversion to Saturn V.

4.7 Pneumatic Control System - The Saturn IB/S-IVB-F stage will have a pneumatic pressure control system that will include one ambient helium bottle mounted on the thrust structure and filled from a GFE ground source.

4.8 Propellant Fill, Drain, and Umbilical Connections - A production-configuration propellant loading, topping control, and drain system will be provided in the S-IVB-F stage. The system will provide signals to determine loading status. The above operations will be designed to be performed automatically and continuously. It is expected that final topping will occur during the propellant tank prepressurization cycle. Loading and topping will be accomplished through a single fill connection. The fill system will be capable of filling the propellant tanks within 55 minutes. Two manually-connected propellant fill nozzles will be capable of automatic disconnection. These two fill connections, together with other propulsion system umbilical connections, will be located in the aft umbilical in a sector that extends approximately two feet on either side of the line located 73 degrees from Position I toward Position II. The additional umbilical connections will be as follows:

- a. Cold helium fill and  $\text{LO}_2$  prepressurization
- b.  $\text{LH}_2$  tank prepressurization
- c. Ambient helium control sphere pressurization
- d. APS (Auxiliary Propulsion System) system bottle supply fill

4.9 Propellant Feed Lines - The  $\text{LO}_2$  and  $\text{LH}_2$  feed lines will not be provided. The  $\text{LH}_2$  tank elbow and the  $\text{LO}_2$  sump port will be capped with blank closure flanges.

4.10 Propellant Vent Lines - The  $\text{LH}_2$  vent system will be of production configuration, except that the liquid separator and flight vent ducting will not be provided. The vent holes will be capped and simulated vent nozzles installed. Vent gas from the  $\text{LH}_2$  tank will be ducted through the forward skirt to a flight coupling on the forward umbilical. The  $\text{LO}_2$  vent system will be of production configuration. Vent gas from the  $\text{LO}_2$  tank will be ducted through the aft skirt.

4.11 Propellant Recirculation Chillydown System - The  $\text{LO}_2$  and  $\text{LH}_2$  recirculation chillydown systems will not be provided. Blank closure flanges will be installed.

4.12 Auxiliary Propulsion System - One Saturn IB-configured APS module plus one mockup module (structural fairing) will be installed. The APS module (No. 2) will be completely functional only in regard to propellant tanking/detanking operations and associated safety equipment. APS engines will not be provided. Jumper lines will be installed to replace engines. The outer contour of the mockup module will be the production structural fairing. Each module will have inlet and outlet flow characteristics to permit the environmental control system to operate properly. The propellants for the APS module will be contained in expandible metal bellows under controlled pressure. The oxidizer and fuel flow during tanking and detanking will be controlled by solenoid control valves. Pressurization will be achieved by introducing gas between the expandible metal bellows and the tank shell in which it is contained. The APS module will be loaded semi-automatically during pre-launch operations. The APS system will use as propellants monomethylhydrazine and nitrogen tetroxide.

4.13 Leak Detection System - Automatic leak detection capability will not be provided for any system or subsystem. Manual leak checks will be employed (as required).

4.14 Firings and Calibrations - No static firings, propellant tank volume calibrations, or cryogenic calibrations of the propellant mass sensors will be performed.

4.15 Purging Requirements - The S-IVB-F propellant tanks will be purged with nitrogen gas to restrict contamination from other gases to less than one per cent. A constant nitrogen gas blanket purge will be maintained on the S-IVB-F stage while the stage is on the test stands or at the launch complex. The propellant tanks will be repurged after any entry of personnel. Before propellant loading, a hydrogen or helium purge will be used to remove the nitrogen blanket purge from the  $\text{LH}_2$  tank. The normal nitrogen purge will be maintained in the  $\text{LO}_2$  tank. Whenever the propellant tanks are unloaded, the tanks will be repurged to meet the above requirements.

## 5. ELECTRICAL/ELECTRONIC SYSTEMS

5.1 General - The S-IVB-F stage will be provided with only those electrical and electronic systems required to operate the following functional systems: propellant utilization system, fill and drain system,  $\text{LH}_2$  and  $\text{LO}_2$  pressurization systems, APS system, and the instrumentation defined in paragraph 5.5. All stage status indications hardwired to the umbilicals in the S-IVB-F are listed in Appendix B.

5.2 Power Requirements - In accordance with the requirements for flight stages 201 and 501, all external power to the S-IVB-F stage will be provided as GFE from the facilities support equipment by means of the flight umbilicals. Power distribution and other electrical/electronic networks will be installed (as required) to integrate stage subsystems and pressure switches, valves, and similar items.

5.3 Interface Wiring - No electrical wiring installations between the Instrument Unit (IU-F) and the S-IB-F/S-II-F stages will be provided with the S-IVB-F stage.

5.4 Propellant Utilization System - A production configuration PU system will be installed in the stage. The system will be used to sense (as required)  $\text{LO}_2$  and  $\text{LH}_2$  levels during fill and drain operations. The PU system will have the following major components:  $\text{LH}_2$  mass sensor,  $\text{LO}_2$  mass sensor, and PU electronics assembly.

The engine mixture-ratio valve positioner and motor will not be installed. The  $\text{LH}_2$  and  $\text{LO}_2$  mass sensors will be capacitors suitably positioned in the tanks. As these units are submerged, their capacitance will increase. The mass sensors will form one portion of the three-wire, servo-balanced, capacitance bridge. The output of the bridge will be indicated by the shaft position. This shaft will be used to drive a potentiometer wiper to obtain a voltage signal. During loading, this signal will be supplied to the ground loading computer by hardwire through the forward umbilical. One "not overfilled" sensor will also be installed with the PU system in each propellant tank and hardwired to the umbilicals.

5.5 Instrumentation - Instrumentation measurements (reference Appendix D, page 25 ) will be carried on the DDAS link which is composed of a Model 270 Multiplexer and a Model 301 PCM/DDAA, both located in the forward skirt. The measurements, primarily of the pressure monitoring and of the miscellaneous type, will be fed directly to the Model 270 Multiplexer (0 - 5 vdc hi-level measurements). One signal conditioning rack will provide signal conditioning for the temperature, voltage, and frequency type measurements (low level measurements). The information carried on the DDAS link will be transferred from the PCM/DDAA by way of a coaxial cable to GSE. Provisions will also be made to use one channel decoder and one central command decoder to supply commands to modules capable of accepting RACS (Remote Automatic Calibration System) inputs. The Model 270 Multiplexer and Model 301 DDAS Assembly are in addition to that authorized in Change Order 171. This equipment shall be procured in accordance with the MSFC drawings specified in Change Order 220.

All necessary S-IVB flight-configuration instrumentation will be installed to

- (1) monitor the performance of the propellant and gas servicing systems, and
- (2) provide the associated signals from the stage. This will include safety and interlock circuitry. Propellant tank instrumentation probes will not be installed. The functional portions of the installed physical interfaces will be identical to those of Flight Stages 201 and 501 except for additional instrumentation functions peculiar to the S-IVB-F stage.

Protruding flight instrumentation which is not required will be simulated by envelope mockup units furnished in kits for installation at KSC.

5.6 Electrical Umbilical Disconnects - There will be sufficient electrical umbilical connectors to carry all necessary electrical functions up to simulated liftoff. The electrical umbilical disconnects will consist mainly of 60-pin electrical connectors mounted on a common carrier plate which can be separated from the stage at the signal for liftoff. The functional portions of the S-IVB-F umbilicals will be identical to Flight Stages 201 and 501 except for deletions due to non-existent systems. The umbilical cables will be supported by the GFE swing arm mounted on the umbilical tower which supports the carrier plate.

## 6. MECHANICAL SYSTEMS

6.1 General - The S-IVB-F stage mechanical systems and components will be of production configuration and will be identical to that required for Flight Stages 201 and 501, except as modified by S-IVB-F mission requirements. These requirements are identified in the following paragraphs.

6.2 Hydraulic Power System - The S-IVB-F stage will not have a hydraulic power system or a hydraulic control system for engine gimbaling.

6.3 Umbilicals - The S-IVB-F umbilicals will be of production configuration, except as modified to perform S-IVB-F stage functions. Umbilical functions will include main propulsion system propellant fill, propellant tank pressurization, control gas fill, air conditioning, and electrical control. Two umbilicals will service the stage. A forward umbilical will provide electronic cables and pneumatic lines for DAC-furnished electronic systems, and will carry vented  $\text{GH}_2$  from the stage. The forward umbilical will be centered 56 degrees, 40 minutes from Position I toward Position II. An aft umbilical, centered 73 degrees from Position I toward Position II, will be provided for propellant fill and drain, high-pressure gas servicing, main propellant tank prepressurization, and electrical control. An access door will be provided in the aft interstage below the aft umbilical. APS propellant fill provisions will be provided with the APS module. (See paragraph 4.8 for propulsion umbilical description, and paragraph 5.6 for electrical umbilical description).

## 6.4 Environmental Control System

6.4.1 General - The temperature-sensitive components located in the S-IVB-F stage will have a thermally-conditioned environment for (1) operation within the required design limits, and (2) protection against extremely low temperatures experienced by those components in close proximity to cryogenic propellants during a 12-hour ground hold. The S-IVB-F environmental system will be of production configuration, but will be modified to perform the S-IVB-F stage mission. Open holes in the forward and aft purge areas resulting from the deletion of equipment or installations will be closed to maintain the purge systems as close as possible to flight requirements.

6.4.2 Aft Skirt and Aft Interstage - For safety purposes, preflight purge of  $\text{GN}_2$  will be initiated before  $\text{LH}_2$  loading and maintained to reduce the oxygen content of the aft area, and to provide thermal environmental conditioning of the equipment, as required. Conditioned air or  $\text{GN}_2$  (supplied by GFE equipment at KSC) and by Model 326 at Sacramento (air only) will be directed through an umbilical connection at the S-IVB-F stage skin to a distribution manifold located inside the stage. The manifold will be formed by enclosing the forward area between the  $\text{LO}_2$  tank wall and the skirt structure with a flexible membrane. A method of venting the aft interstage will be provided. For the Saturn IB configuration, air conditioning will be confined to the S-IVB-F stage since the S-IB-F stage will be sealed off.

6.4.3 Forward Skirt - Except for the IU-F interface connectors and brackets, the forward skirt thermoconditioning plates and related plumbing will not be provided. For safety purposes, a  $\text{GN}_2$  purge will be initiated by NASA/KSC or Sacramento before  $\text{LH}_2$  loading and maintained to (1) reduce the oxygen content of the forward skirt, and (2) provide the necessary thermal environmental conditioning of the S-IVB-F equipment to maintain it within design limits. The purging gas will be supplied by GFE equipment at KSC. The forward skirt purge will be integrated with the purge of GFE electronic equipment located above the S-IVB-F stage and will be provided through the IU-F umbilical.



7. ORDNANCE EQUIPMENT

7.1 General - Dummy ordnance installations will be provided for the S-IVB-F stage in place of production hardware on both Saturn IB and Saturn V configurations. The following paragraphs describe the ordnance equipment for each configuration.

7.2 Saturn IB Ordnance Equipment - The following dummy ordnance items (furnished in kit form for installation at KSC) will be installed on the Saturn IB/S-IVB-F stage:

- a. An S-IB retro-rocket system, installed on the S-IVB-F aft interstage, and consisting of one dummy rocket, four rocket supports, and four rocket fairings.
- b. An ullage rocket system consisting of:
  - (1) Four rocket supports
  - (2) One jettisonable fairing assembly containing:
    - (a) One dummy rocket motor
    - (b) Two dummy EBW firing units
    - (c) One dummy chamber pressure transducer with bracket and plumbing
    - (d) One dummy electrical disconnect and associated hardware
  - (3) Three empty jettisonable fairing assemblies, including fairing nose covers
  - (4) One dummy jettisonable system CDF (Confined Detonating Fuse) train and attaching hardware
- c. Propellant Dispersion System, including dummy explosives, trains, attaching hardware, and a safe and arming device.
- d. Stage Separation System, including a dummy MDF train with attaching hardware.

8. WEIGHT

8.1 General - Unless specifically called out in this specification, the absence of production hardware in the S-IVB-F stage will not require the installation of ~~dummy~~ mass simulators. If required, mass simulators will be installed to (1) obtain a stage dry weight of not less than 90 per cent for Flight Stages 201 and 501, and (2) maintain the nominal flight configuration cg (center of gravity) of Flight Stages 201 and 501 within a tolerance of plus or minus 10 per cent of overall stage length.

9. LAUNCH SAFETY PROVISIONS

9.1 General - Dummy ordnance items will be provided in accordance with Section 7. The S-IVB-F stage will have provisions for accommodating the installation of GFE safety receivers and safety controls. An antenna system will not be provided; however, any protrusion will be simulated by envelope mockup units.

## 10. GENERAL REQUIREMENTS

10.1 Data Acquisition and Processing System - The DDAS system will be installed in the S-IVB-F stage. Instrumentation provisions will be in accordance with paragraph 5.5.

10.2 Human Factors Engineering - Application of human factors engineering principles in the S-IVB-F stage will be in accordance with Section 17 of DAC Specification DS-2163.

10.3 Materials and Processes - Materials and processes used in the S-IVB-F stage will be in accordance with Section 18 of DAC Specification DS-2163.

10.4 Preparation-for-Delivery Requirements - The preparation-for-delivery requirements of the S-IVB-F stage will be in accordance with Section 19 of DAC Specification DS-2163.

10.5 Quality Assurance Provisions - The quality assurance standards applied to the S-IVB-F stage will be in accordance with Section 20 of DAC Specification DS-2163.

10.6 Government-furnished Equipment Requirements - The GFE requirements established to support the S-IVB-F stage will be in accordance with the provisions stipulated in SM-41413, Program Plan, Saturn V/S-IVB System, and SM-43568, Program Plan, Saturn IB/S-IVB System.

10.7 Documentation - Documentation requirements to support design and development of the S-IVB-F stage will be as spelled out in Appendix C. A list of engineering control drawings (mechanical and electrical), and the required submittal date, will be added to the specification (as Appendix E) when established by DAC/MSFC agreement.

10.8 Exterior Finish - The exterior finishes of the S-IVB-F stage shall be in accordance with the requirements of Flight Stages S-IVB/IB and S-IVB/SV.

## APPENDIX A

### List of S-IVB-F Stage Status Indications

#### Umbilical Function

P.U. LOX Loading Potentiometer Measurement Signal  
P.U. Fuel Loading Potentiometer Measurement Signal  
Plug Supervision Circuit Input  
Plug Supervision Circuit Output  
Fuel Tank Vent - Full Closed  
Fuel Tank Vent - Full Open  
Fuel Tank Not Overfilled  
Fuel Tank Liftoff Pressure OK  
Fuel Tank Ground Fill Overpressure  
Fuel Tank Pad Safety Pressure OK  
Forward Power ON (Internal)  
Level Sensor Power ON  
Inverter and P.U. Power ON  
Plug Supervision Circuit Input  
Plug Supervision Circuit Output  
LO<sub>2</sub> Tank Fill and Drain Closed  
Digital Data Acquisition Power ON Indication  
Digital Data Acquisition Power OFF Indication  
LO<sub>2</sub> Tank Fill and Drain Open  
LO<sub>2</sub> Tank Not Overfilled  
LO<sub>2</sub> Tank Vent - Full Closed  
LO<sub>2</sub> Tank Vent - Full Open  
LO<sub>2</sub> Tank Ground Fill Overpressure  
LO<sub>2</sub> Tank Minimum Liftoff Pressure OK  
LO<sub>2</sub> Tank Pad Safety Pressure OK  
Fuel Tank Fill and Drain Closed  
Fuel Tank Fill and Drain Open  
Pressure Switch Power ON  
APS 2 Helium Regulator Failure  
Aft Bus 1 ON (Internal)  
APS 2 Fuel Tank Helium Pad Safety Pressure OK  
APS 2 Oxidizer Tank Helium Pad Safety Pressure OK  
APS 2 Helium Pressure (Low)  
APS 2 Helium Pressure (High)

APPENDIX A (continued)

APS 2 Helium Sphere Pad Safety Pressure OK  
APS 2 Helium Sphere Liftoff Pressure OK  
APS 2 Helium Regulator System OK  
APS 2 Oxidizer Tank 100% Fill  
APS 2 Fuel Tank 85% Fill  
APS 2 Fuel Tank 100% Fill  
APS 2 Oxidizer Tank 85% Fill  
Cold Helium Sphere Liftoff Pressure OK  
Cold Helium Sphere Pad Safety Pressure OK  
Ambient Helium Sphere Minimum Liftoff Pressure OK  
Ambient Helium Pad Safety Pressure OK  
APS Environmental Temperature Indication Excitation  
APS Environmental Temperature Indication Return  
DDAA 600 KC FM Modulated Indication  
APS Environmental Temperature Control Excitation  
APS Environmental Temperature Control Return  
Plug Supervision Circuit Input  
Plug Supervision Circuit Output

Forward Bus 1-volt Sense Indication  
Forward Bus 1-volt Indication  
Forward Bus 1-volt Indication Return  
Forward Bus 1-volt Sense Indication Return  
Forward Bus 2-volt Sense Indication  
Forward Bus 2-volt Indication  
Forward Bus 2-volt Sense Return  
Forward Bus 2-volt Indication Return  
Aft Bus 1-volt Sense Indication  
Aft Bus 1-volt Indication  
Aft Bus 1-volt Sense Indication Return  
Aft Bus 1-volt Indication Return  
Cold Helium Regulator Backup Pressure Switch Enabled

## APPENDIX B

Tabulated below are all contractually binding CCN's, supplemental agreements, change orders, and contract letters initiated through No. 367, which have an effect upon S-IVB-F stage design and development.

MODIFICATION	SCOPE CHANGE		CONFIGURATION	
			S-IB	S-V
C. O. 34, 42	1075B	Propellant Tank Pressure Redesign	X	X
C.O. 54, 160. 207, 238	1104A	Design and Tests for Umbilicals (partial)	X	X
C.O. 80	1060	Increased Length of Aft Interstage		X
C.O. 95	1011B	S-II Retro-rockets on S-IVB Aft Interstage		X
C.O. 293, 310	1092A	Aft Interstage Rework - Access Kit		X
C.O. 25	1096	Removal of Heat Barriers	X	X
C.O. 111, 126	1189	Additional Coast Requirements (Optional I-CO-VB dtd 4/1/64)	X	
C.O. 114	1102A	S-IB Retro-rockets on S-IVB Aft Interstage	X	
S.A. 149	1100C	Updates Facility C/O Stage S-IB	X	X
C.O. 173	1205	Additional Interface Connectors		X
C.O. 197, 213, 330, 343	1207	Modification of P.U. System (partial)	X	X
C.O. 146, 206	1330	Signal Conditioning Requirements for Measurement (M-12 only)	X	X
C.O. 210	1221 1344	Redesign APS for Ullage System APS Propulsion Tankage		X
C.O. 217	1118A	Standard Nomenclature (reference Non-hardware)	X	X
C.O. 218	1117A	Electrical System Schematics and Cable Diagrams (non-hardware)	X	X
C.O. 229	1030A	Revised Stage Transportation Plan	X	X
C.O. 261	1180A	Addition of Stage Alignment Targets	X	X
C.O. 156	1193	Revised Stage LOX Tank Vent Line	X	X
C.O. 267	1276	Electrical Interface Connector	X	X
C.O. 273				X
	1270	Common Bulkhead Evacuation System	X	X
C.O. 271	1278	Redesign Circuitry for Coarse-loading Potentiometers	X	X

APPENDIX B (continued)

<u>MODIFICATION</u>	<u>SCOPE CHANGE</u>	<u>DESCRIPTION</u>	<u>CONFIGURATION</u>	
			<u>S-IB</u>	<u>S-V</u>
C.O. 284, 330	1297	Forward Skirt Venting	X	X
C.O. 316	1255	Instrumentation Program and Components List	X	X
S.A. 361	ECP-X011	Additional Requirements - S-IVB Facility Checkout Stage	X	X
I-CO-SD-L-138	ECP-X015	Facility Checkout Stage - Simulated Engine	X	X
C.O. 367	ECP-X010	Standardization of Operating and Measuring Signals	X	X
C.O. 353	1378	GN <sub>2</sub> Purge Supply Remote Control System	X	X
C/L 64-53 C.O. 146, 206	1196	Revised Structural Loads *(Affects Hole Pattern in Saturn V only)	X	X*



### APPENDIX C

DAC shall prepare and submit to MSFC the following S-IVB-F documentation on or before 1 May 1965: (The S-IVB-Data Submittal Document, SM-41410, is used as a reference base.)

<u>Paragraph of SM-41410</u>	<u>Title of Data Required</u>	<u>Number of Copies</u>
5.12.7	Final Test Results (HB Factory Checkout)	10
5.16.1	Transportation and Handling	5
5.16.2	Checkout Procedures	5
5.16.5	Inspection	5
5.16.6	Stage Alignment Control Procedures	5
5.16.7	Stage Alignment Control Data	5
5.16.8	Proposed Countdown Procedure	5
5.16.10	Instrumentation Plan	5
5.17.4	Inspection Records	as requested
5.17.5	Stage Log Books	1 set
5.19.3	Functional Stage Diagrams	5
5.20.1	(a) End Item Drawing List	1 (1)
	(b) Section List	1 (1)
	(c) System Generation Breakdown	1 (1)
5.20.2	Drawings	2 sets
5.20.3	Autopositives	(2)

NOTE: Parenthesis indicates reproducible.

# APPENDIX D

## S-IVB-F/IB Measurement Program

Measurement Number		
(1)	C210	Temperature - Cold Helium Sphere No. 4
(2)	C253	Temperature - Ambient Helium Sphere
(3)	C167	Temperature - Helium Sphere Gas - Mod 2 (APS)
(4)	D016	Pressure - Cold Helium Sphere
(5)	D021	Pressure - LH <sub>2</sub> Tank Ullage
(6)	D022	Pressure - LOX Tank Ullage
(7)	D160	Pressure - Helium (Ambient) Sphere
(8)	D068	Pressure - Helium Regulator Inlet - Mod 2 (APS)
(9)	D069	Pressure - Helium Regulator Outlet - Mod 2 (APS)
(10)	D091	Pressure - Fuel Tank Ullage - Mod 2 (APS)
(11)	D092	Pressure - Oxidizer Tank Ullage - Mod 2 (APS)
(12)	D096	Pressure - Fuel Tank Outlet - Mod 2 (APS)
(13)	D095	Pressure - Oxidizer Tank Outlet - Mod 2 (APS)
(14)	D014	Pressure - Vent Valve Actuation
(15)	D054	Pressure - Fuel Tank Inlet
(16)	D055	Pressure - LOX Tank Inlet
(17)	D105	Pressure - LOX Tank Pressure Module Helium Gas
(18)	N038	Misc.-Quantity, Oxidizer Tank - Mod 2 (APS)
(19)	N040	Misc.-Quantity, Fuel Tank - Mod 2 (APS)
(20)	N002	Misc.-P.U. System LH <sub>2</sub> Fine Mass
(21)	N004	Misc.-P.U. System LOX Fine Mass
(22)	M001	Volt - Static Inverter Converter
(23)	M012	Frequency - Static Inverter Converter
(24)	M004	Volt - Static Inverter Converter 5 VDC
(25)	D208	Pressure - Common Bulkhead Internal
(26)	M024	Volt - Five-volt Excitation Module Forward

APPENDIX E

S-IVB-F/V Measurement Program

- (a) Instrumentation to be retained from the S-IVB-F/IB configuration which is common to the Saturn V.

Measurement No.

1.	C210	Temperature, Cold Helium Sphere No. 4
2.	D014	Pressure, Vent Valve Actuation
3.	D016	Pressure, Cold Helium Sphere
4.	D021	Pressure, Fuel Tank Ullage
5.	D022	Pressure, Oxidizer Tank Ullage
6.	D054	Pressure, Fuel Tank Inlet
7.	D055	Pressure, Oxidizer Tank Inlet
8.	D105	Pressure, Oxidizer Tank Pressure Module
9.	D208	Pressure, Common Bulkhead Internal
10.	M001	Volt - Static Inverter Converter
11.	M004	Volt - Static Inverter Converter 5 VDC
12.	M012	Frequency - Static Inverter Converter
13.	M024	Volt - Five-volt Excitation Module Forward
14.	N002	Misc. P.U. System LH <sub>2</sub> Fine Mass
15.	N004	Misc. P.U. System LOX Fine Mass
16.	N001	Misc. P.U. System LH <sub>2</sub> Coarse Mass
17.	N003	Misc. P.U. System LOX Coarse Mass
18.	Umbilical	Bus Voltage 4D11
19.	Umbilical	Bus Voltage 4D21
20.	Umbilical	Bus Voltage 4D31

APPENDIX E (continued)

(b) Instrumentation to be added:

	Measurement No.	
1.	C205	Temperature, Helium Sphere No. 4
2.	C021	Temperature Fuel Outlet APS No. 2
3.	C022	Temperature Oxidizer Tank Outlet - APS No. 2
4.	D020	Pressure - Fuel Tank Repressurization Spheres
5.	TBD	Pressure - Fuel Tank Ullage
6.	D087	Pressure - Pneumatic Control Sphere
7.	D088	Pressure - Oxidizer Tank Repressurization Sphere

(c) Instrumentation to be changed:

	Measurement No.	
	S-IVB-F/S-IB	to S-IVB-F/V
1.	C187	C167 Temperature - He Gas APS No. 2
2.	D024	D096 Pressure - Fuel Tank Outlet - APS No. 2
3.	D026	D095 Pressure - Oxidizer Tank Outlet - APS No. 2
4.	D036	D068 Pressure - He Regulator Inlet, APS No. 2
5.	D038	D069 Pressure - He Regulator Outlet, APS No. 2
6.	D100	D091 Pressure - Fuel Tank Ullage, APS No. 2
7.	D099	D092 Pressure - Oxidizer Tank Ullage, APS No. 2
8.	N042	N038 Misc.-Quantity, Oxidizer Tank, APS No. 2
9.	N044	N040 Misc.-Quantity, Fuel Tank, APS No. 2

SECTION II  
SATURN S-IVB/S-V-1

TABLE OF CONTENTS

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
3.	CONFIGURATION DESCRIPTION, S-IVB/V	28
3.1	General	28
3.2	Structure	28
3.2.1	Forward Skirt	28
3.2.2	Propellant Tank Assembly	28
3.2.3	Thrust Structure	28
3.2.4	Aft Skirt	29
4.	PROPULSION SYSTEM	30
4.5	Liquid Hydrogen Pressurization	30
4.6	Liquid Oxygen Pressurization	30
4.7	Pneumatic Control System	30
4.8	Auxiliary Propulsion System	30
5.	ELECTRICAL/ELECTRONIC SYSTEMS	31
5.5	Instrumentation	31
6.	MECHANICAL SYSTEMS	32
6.4.2	Aft Skirt and Aft Interstage	32
7.	ORDNANCE EQUIPMENT	33
7.3	Saturn V Ordnance Equipment	33
8.	WEIGHT	34
8.1	General	34

### 3. CONFIGURATION DESCRIPTION, S-IVB/V

3.1 General - The S-IVB-F stage will be delivered to KSC in the Saturn S-IB configuration. A retrofit kit will be provided for conversion of the S-IVB/IB Facility Checkout Stage to the Saturn V configuration by DAC personnel at KSC. Included in this kit will be a Saturn S-IVB/V flared aft interstage. The functional requirements of the stage will be limited to the Saturn V-peculiar propulsion and electrical systems required to safely load and unload propellants, pneumatic servicing, and compartment purges. The functional portions of the interfaces will be identical to those of flight stage 501, except for the S-IVB-F-peculiar instrumentation.

3.2 Structure - The S-IVB-F will be a single stage structure capable of withstanding all loads imposed during normal handling and facility checkout operations. The stage will also have free-standing capability when staged as a complete Saturn V vehicle, either pressurized or unpressurized, and loaded or unloaded. The stage will conform to flight configuration except for those parameters not required for mission performance. Protruding flight equipment not required will be simulated by envelope mockup units to be furnished in kit form for installation at KSC.

3.2.1 Forward Skirt - The S-IVB/IB forward skirt will be modified only as required to conform to the Saturn V configuration. Provisions presently installed in the S-IVB/IB forward skirt will not be changed unless required by contract.

3.2.2 Propellant Tank Assembly - The S-IVB-F propellant tank assembly will be of the production configuration. It will be the assembly presently a part of the Saturn S-IVB/IB Facility Checkout Stage.

3.2.3 Thrust Structure - No change in the S-IVB/V configuration will be made except to install the ambient helium spheres not a part of the existing structure of the S-IVB/IB Facility Checkout Stage.

3.2.4 Aft Skirt - The existing S-IVB/IB aft skirt will be modified to fulfill the functions of the Saturn V configuration. Modification of the following systems will be made:

- (a) Ullage Rockets - The three Saturn IB simulated ullage rockets and their support fittings will be removed. Two sets of these supports will be relocated midway between stringers 35-36 and 91-92.

Routing of the ullage initiation and jettison systems will be kept to a minimum.

- (b) Ambient and Wiring Panels - No structural modification will be planned.
- (c) External Propulsion Lines Fairings - No structural modifications will be planned.
- (d) Separation Joint Electrical and Propellant Dispersion Disconnects - Structural Modifications will be made to include the Saturn V aft interstage eight disconnects and the propellant dispersion disconnect arrangement.
- (e) MDF Separation Scheme - The aft frame will be modified to accommodate installation of the Saturn V dummy separation fuse.
- (f) Propellant Dispersion System Routing at the Main Tunnel Seals - Close simulation will require extensive rework. Unless otherwise specified, no structural modifications will be made except to provide an additional ordnance feed-through hole for the PDS fuse.
- (g) Batteries - No structural modifications will be made unless specified by the Customer regardless of the differences in number and location of the Saturn V configuration.

4.     PROPULSION SYSTEM

4.5     Liquid Hydrogen Pressurization - The Saturn V design only will provide an on-board ambient repressurization system, including seven helium bottles mounted around the thrust structure and pressurized from a GFE ground source. The bottles will be installed during conversion to Saturn V.

4.6     Liquid Oxygen Pressurization - The Saturn V configuration will have an LO<sub>2</sub> tank repressurization system that will include two ambient high-pressure helium bottles mounted around the thrust structure and filled from a GFE ground source. The helium bottles will be installed during conversion to Saturn V.

4.7     Pneumatic Control System - The Saturn V/S-IVB-F configuration will have a system similar to the Saturn IB/S-IVB-F stage, but the helium bottle will be installed during conversion.

4.8     Auxiliary Propulsion System - One Saturn V-configured APS module (plus one mockup module) will be provided for retrofit installation at conversion. New attach fittings will be provided. In order to accommodate the existing structure, the Saturn V APS will be 1 3/4 inches from the true location. Disjoining the skirt from the tank will be necessary if the true location is a requirement.



5.     ELECTRICAL/ELECTRONIC SYSTEMS

5.5     Instrumentation - Instrumentation for the S-IVB-F/V Facility Checkout Stage will be in accordance with Appendix E.

6.     MECHANICAL SYSTEMS

6.4.2   Aft Skirt and Aft Interstage   -   For the Saturn V configuration, purge gas for the S-II-F forward area will be supplied by the S-IVB-F system. The Saturn IB production-configuration system will be initially installed in the stage and modified (as required) during Saturn V conversion at KSC.

7. ORDNANCE EQUIPMENT

7.3 Saturn V Ordnance Equipment - The dummy ordnance will be furnished in kit form for installation in the Saturn V-S-IVB-F stage at KSC:

- (a) The S-II retro-rocket system, consisting of one dummy rocket, four rocket supports, four rocket fairings, and a CDF charge train installed on the aft interstage. The dummy retro-rocket is retained from the Saturn S-IB/S-IVB-F stage.
- (b) A stage separation system, including a dummy MDF train with attaching hardware.
- (c) A propellant dispersion system, including dummy explosives, trains, attaching hardware, and a safe and arming device.

8.     WEIGHT

8.1    General - If required, mass simulators will be installed to:

- (a)    Obtain a stage dry weight of not less than 90 per cent for Flight Stage 501.
- (b)    Maintain the nominal flight configuration cg (center of gravity) of Flight Stage 501 within a tolerance of plus or minus 10 per cent of overall stage length.



MISSILE & SPACE SYSTEMS DIVISION  
DOUGLAS AIRCRAFT COMPANY, INC.  
SANTA MONICA, CALIFORNIA